



NOvA Electronics/DAQ

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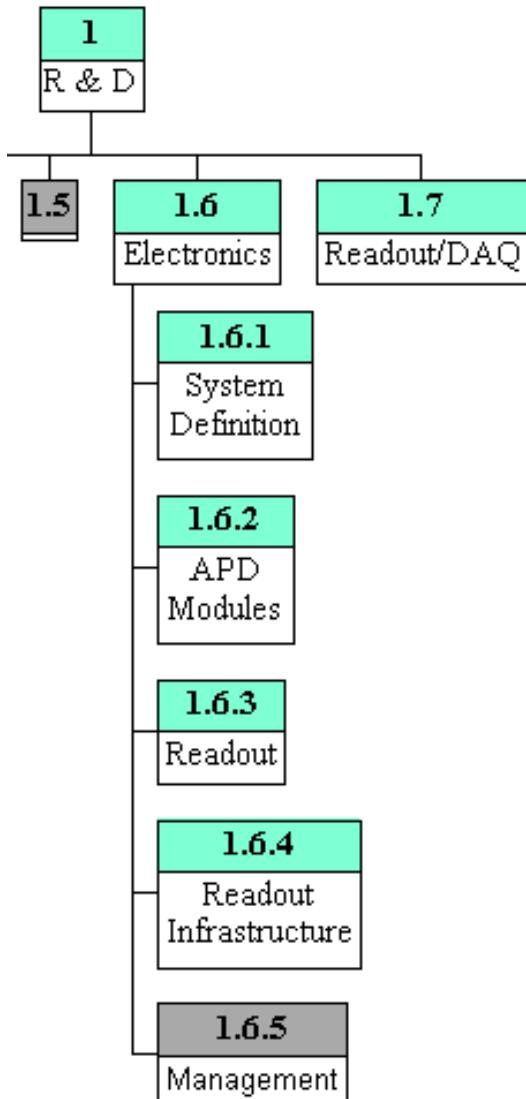
Outline



- Electronics WBS structure
- Recent work in Electronics
- DAQ WBS structure
- Recent work in DAQ
- Open tasks



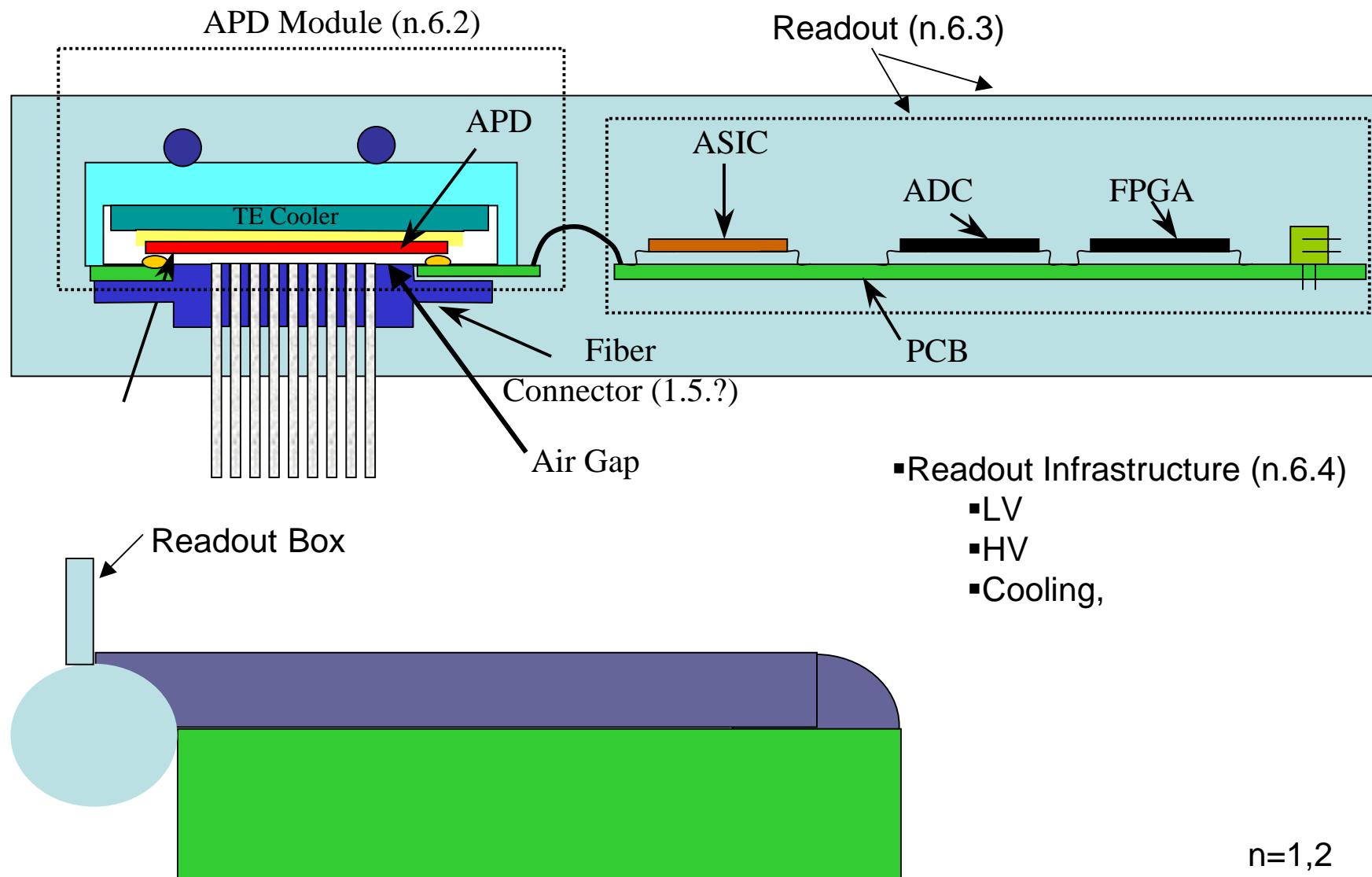
Electronics Organization



- Documentation task
- Major Subsystems
 - APD Modules
 - Readout Modules
 - Readout Infrastructure

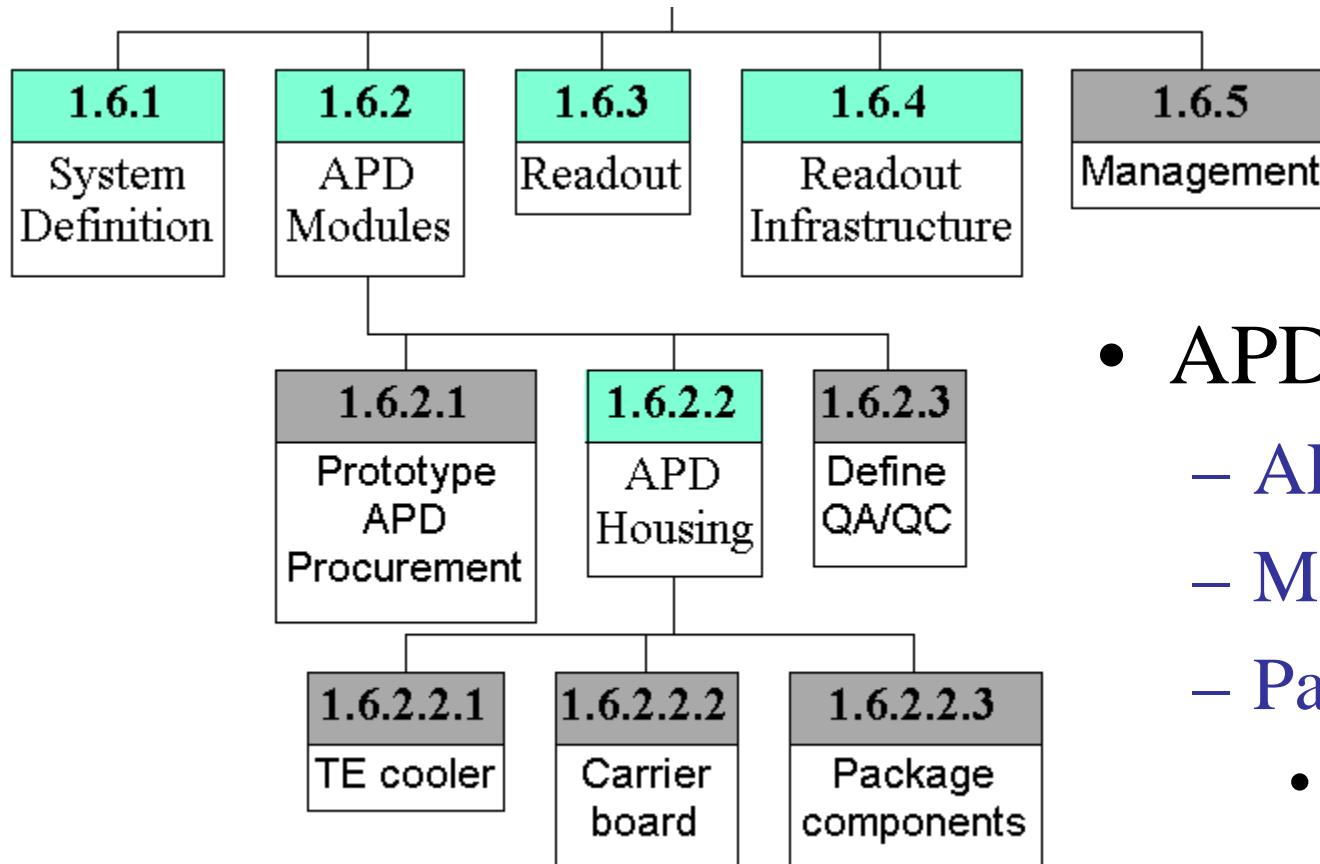


Electronics Concept





APD Modules



- APD Module Task
 - APD
 - Mounting
 - Packaging
 - Alignment
 - Isolation



Front-End Readout options.



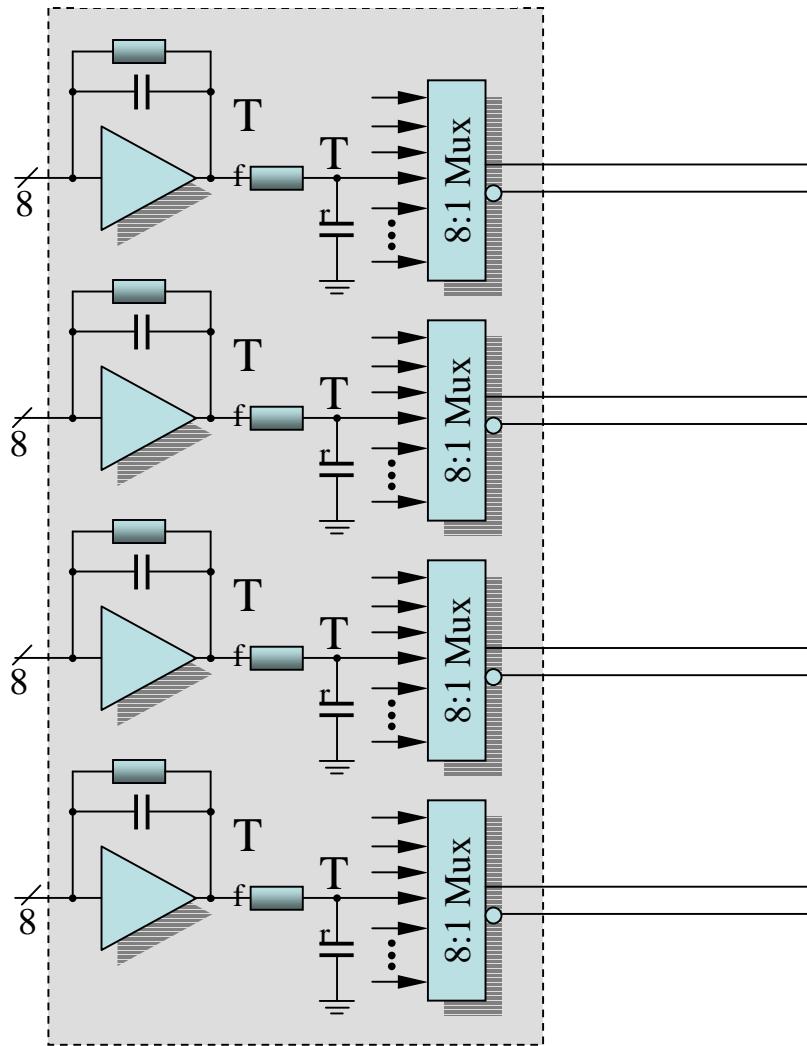
- Two options have been considered for the design of the front-end readout the APD.
- Continuous Digitization
 - 100% live
 - Allows for SuperNOvA triggers
 - Decouples spill trigger delivery
- Pipelined
 - No Digital Activity during acquire—quiet
- Prototype chip will do BOTH



Continuous Digitization



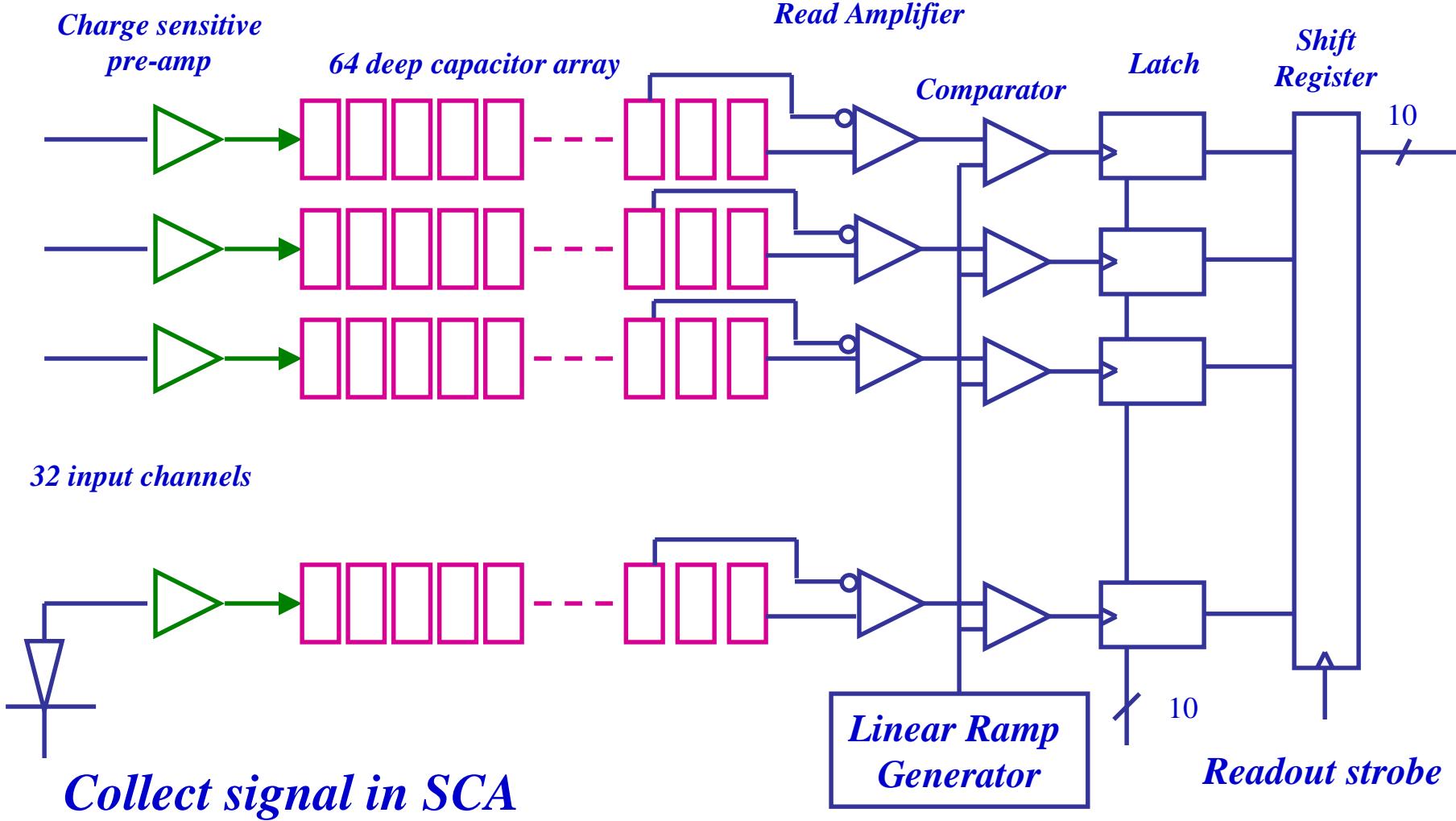
32 channel front end ASIC



- (4x) 8:1 Analog multiplexers
- Each runs at 16 MHz
- 62.5 ns settling time per channel
- 500 ns equivalent sampling time



SCA

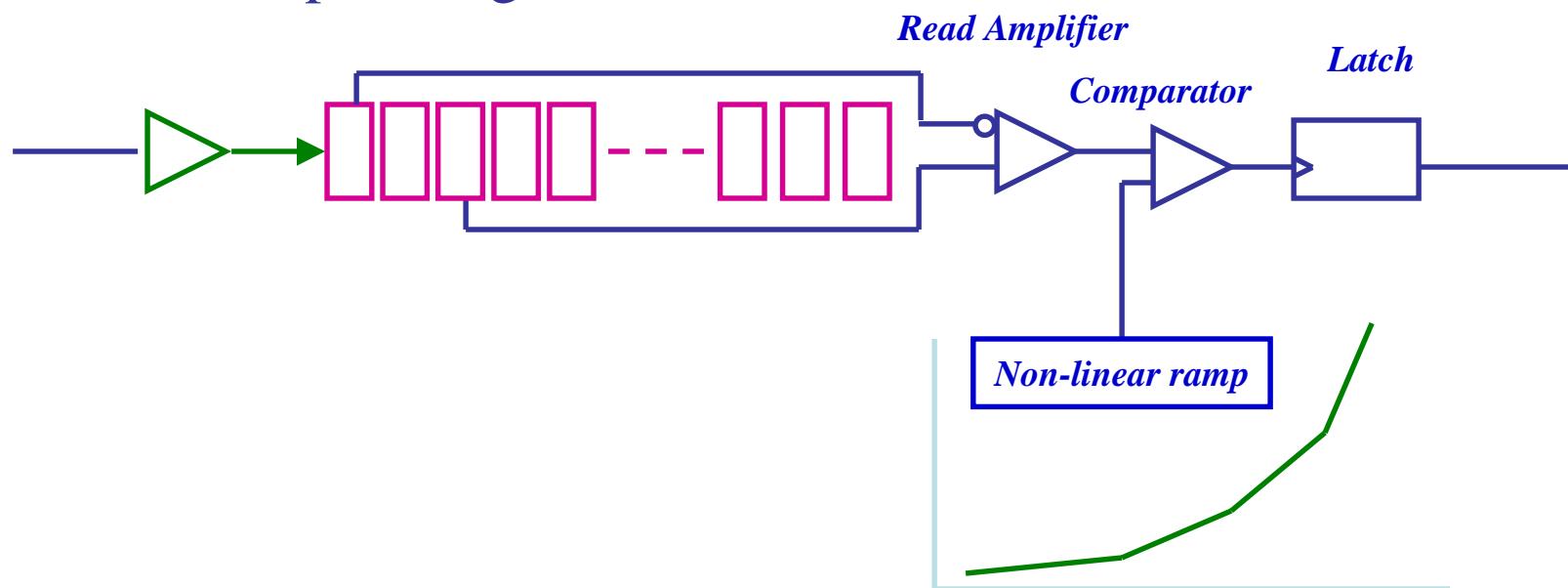




Fast Digitization Mode.



- Variants on the standard operation are included in the design.
 - Direct in to latch.
 - Non-linear ramp.
 - Complete digitization in 400 nsec.





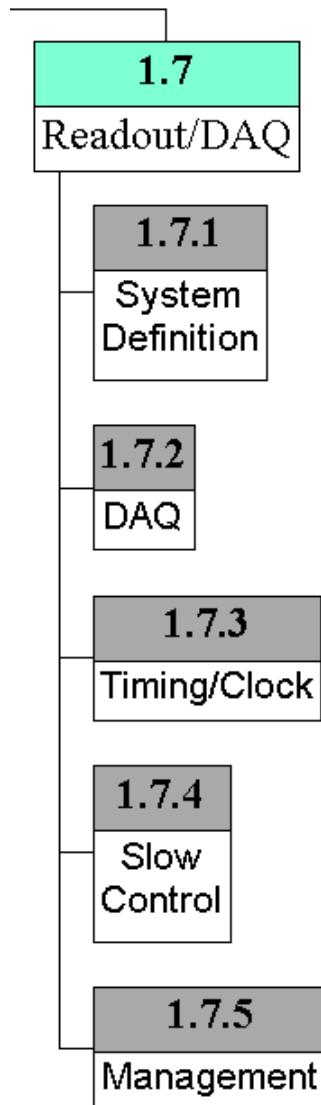
Front-End ASIC Status



- Design complete.
- Full simulations complete. Calculated noise level with 10 pf and 250 nsec shaping is 150 electrons. Reality: expect ~200.
- Layout of one SCA channel complete
- Layout of Control and MUX readout started
- Plan is to submit chip combining all readout options for November MPW run.



DAQ Organization



- Documentation task
- Major Subsystems
 - DAQ/Readout
 - Readout Box -> Enstore
 - Timing/Clock/Spill
 - Sync 500ns digitization clocks
 - Produce/Receive Spill times
 - Slow Control
 - Run control
 - State information, HV, cooling,
 - ...



Issues for DAQ



- Large number of isolated independent elements – 23808 modules with APD boxes
 - Modules don't have enough information to determine interesting events
 - Large background of uninteresting events
 - 99.9% of events are “spare” muons not needed for calibration
- Physically large detector 16m x 16m x 132m
- Remote location – Spill trigger communication



Recent Work in DAQ



- 5-24-2005 Addition of several enthusiastic former BTeV collaborators augments creates “NOvA DAQ group”
 - Mark Bowden, Gerry Guglielmo, Vince Pavlicek, Margaret Votava, ...
- 7-15-2005 Created a DAQ conceptual design for preliminary director's review



Data Rates



- Driven by cosmic muons, ~250kHz, leading to ~400Hz/channel or 12kHz/module rate
 - 120kB/module/s
 - But $23,808 * 120\text{ kB/s} = \sim 3\text{ GB/s}$



Buffering Requirements



- Asynchronous spill trigger requires only 1-2 seconds of buffering
- Buffering driven by Supernova Triggering requiring up to 20 seconds of buffer
 - Most significant signal comes early, so maybe less would be okay



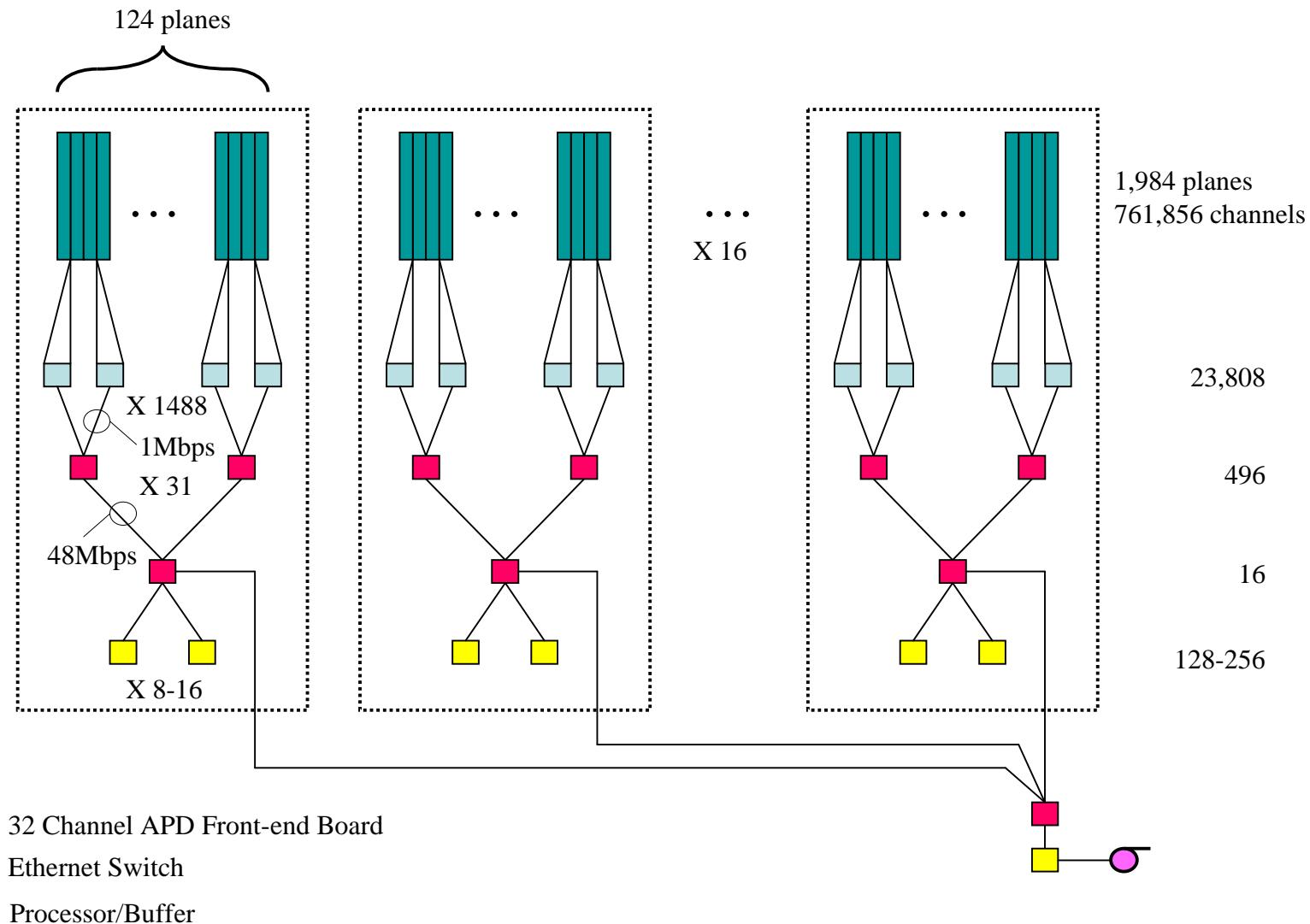
A DAQ Plan



- Subdivide detector into segments
 - 16, 8 each in X and Y
 - Distributes buffering and triggering
 - Each is roughly a giant 16m cube with relatively few muons going between cubes
 - Do simple track finding in cubes to eliminate muon hits
 - Tally number of coincidences from remainder
 - Trigger if threshold met, or timing (in-spill or random) is satisfied

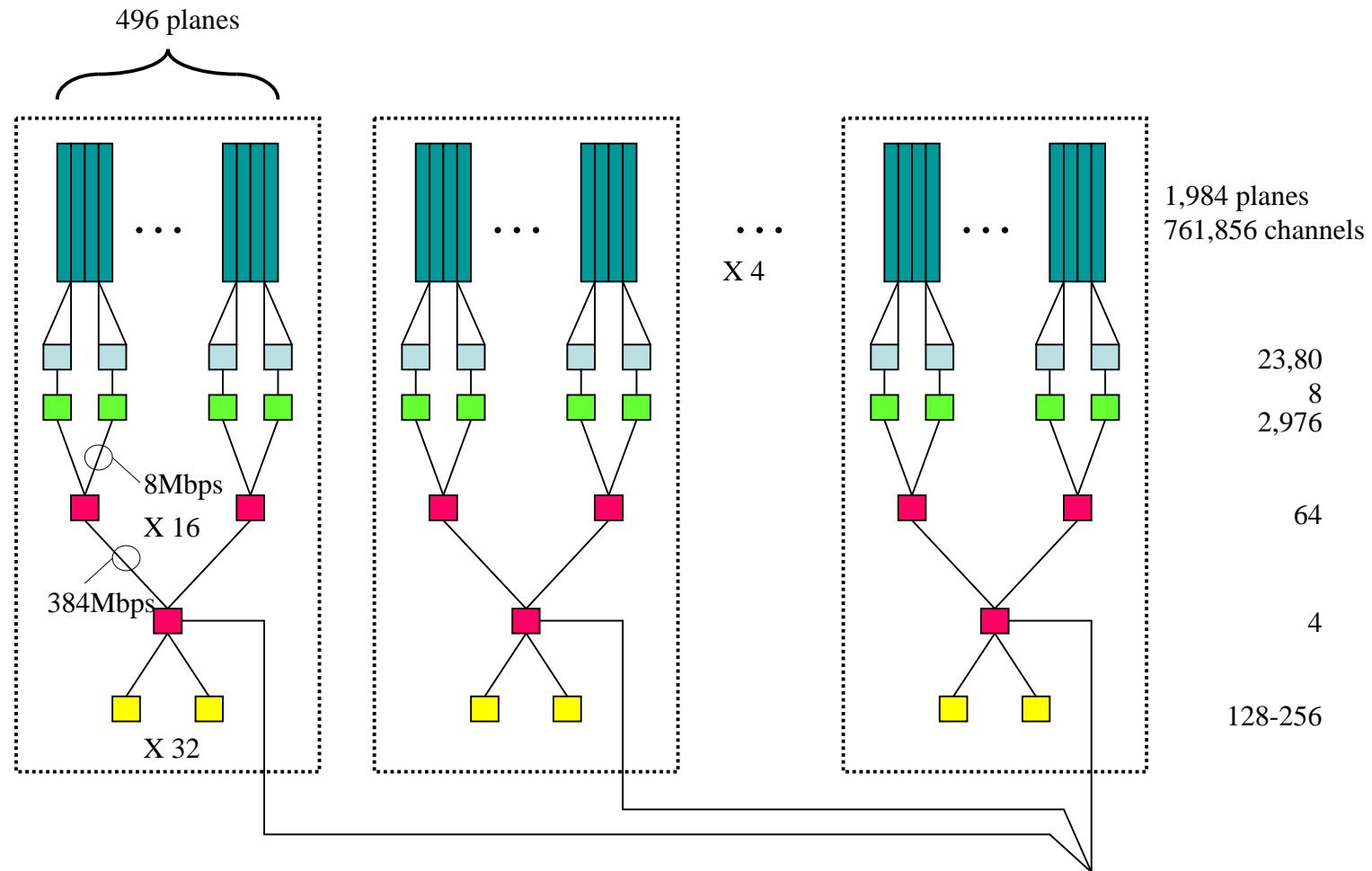


DAQ Diagram





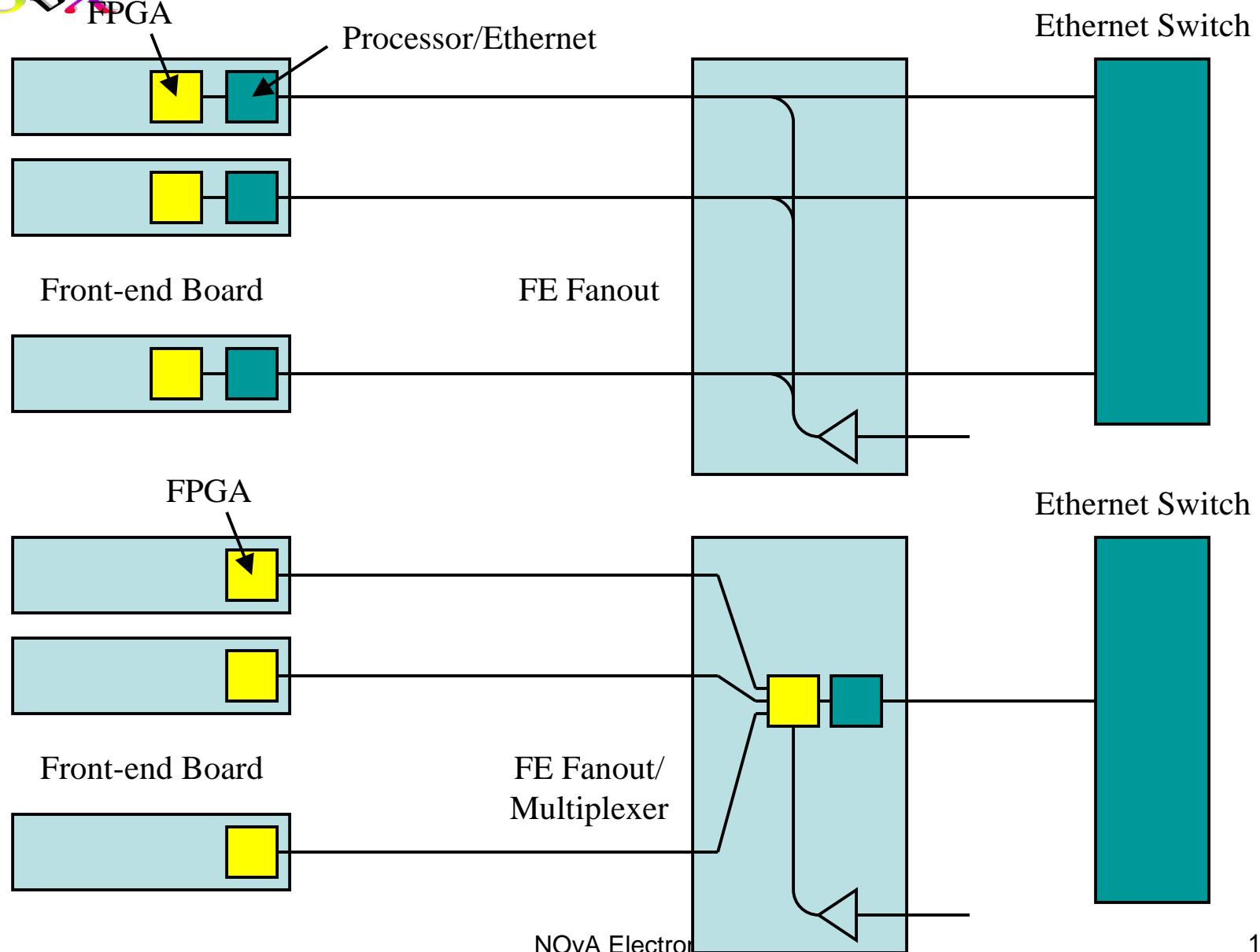
A Plan B



- 32 Channel APD Front-end Board
- Fanout/Multiplexer
- Ethernet Switch
- Processor/Buffer

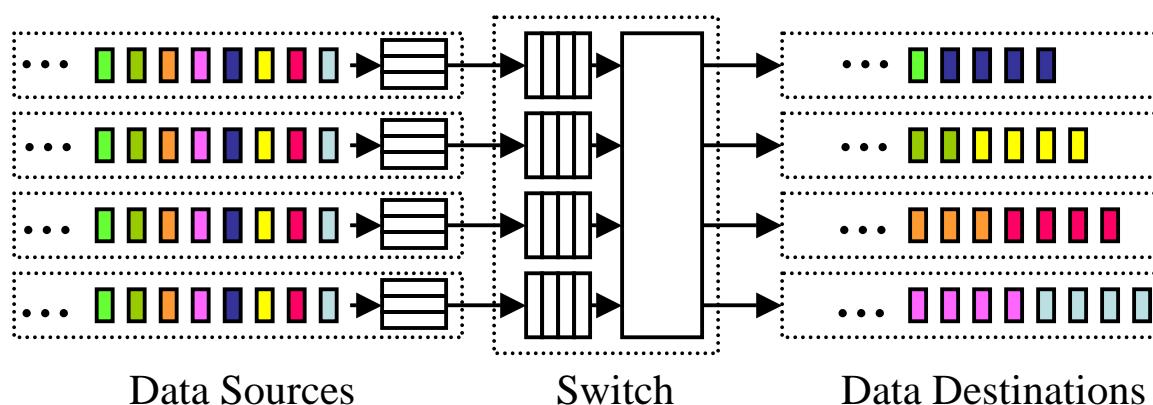
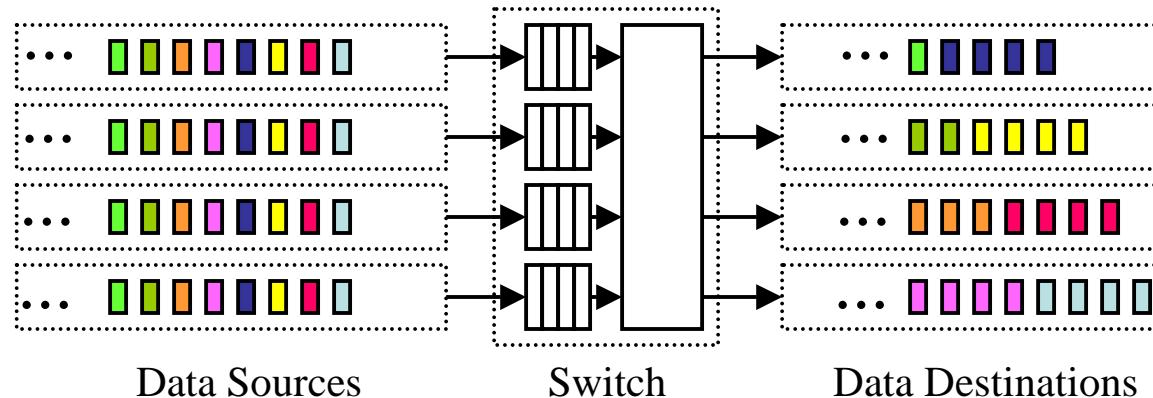


Front-end Interface





Network Buffering Options





DAQ Parameters



- Buffering locations
 - Front end, switch, fan-in
- Time Slicing
- Segmentation
- Optimize Available Bandwidth
- Lots of knobs, lots of decisions



Open Electronics Tasks



- Readout Infrastructure
 - Low Voltage
 - $5\text{W} * 25,000 = 125\text{kW}$
 - 25kW quiet, 100kW not so quiet
 - Reliable
 - High Voltage
 - $400\text{V} * 1\text{nA} * 800,000 = 0.32\text{W}$, very quiet
 - Reliable
 - Cooling
 - Heat sinking 125kW
 - Reliable



Open DAQ Tasks



- DAQ
 - Optimizing time slice, segmentation
 - Efforts at FNAL
 - Supernova Triggering
 - Efforts begun at Harvard
- Timing/Clock/Spill
 - Synchronize digitization
 - Synchronize clocks
 - Send spill times
- Slow Control
 - Run Control
 - HV, Temp setting/readback
 - Record run conditions